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Using Knowledge Creatively

This article is about innovation education, a compulsory school subject in Iceland, somewhat similar to design and technology education in England and other countries. Innovation education has been used successfully as a strategy to enhance students’ understanding of technology and science as they research their own environments and invent objects and technologies that they make themselves, rather than only learning ´about´ technology or science. The article describes how two creative science teachers in Iceland have approached innovation education as a subject and as a tool to enhance and develop creativity in children, making use of knowledge from different subjects and from life. The article builds on fieldwork with two compulsory school science teachers and on written documentation, such as the national curriculum. The stories of the teachers and the story of innovation education in Iceland are told, the characteristics of the two teachers described and examples of their teaching introduced and threaded together by the authors own experiences of teaching innovation education in primary school. Svanborg Rannveig Jónsdóttir was a compulsory school teacher for 28 years in a small rural school, currently a Ph.D. student at the School of Education, University of Iceland and her reseasch is about innovation education in Icelandic compulsory schools.

Picture 1 - Hand-e
This is the idea of two ten year old female students Dórotea and Klara, who were finding a solution to the problem “it’s difficult to hold up your hand for a long time while waiting for the help of your teacher”. They designed this simple thing they called Hand-e that you can take apart and fit into your schoolbag and when you need the help of your teacher you assemble it and put it on your desk and when the teacher comes to help you she or he will take it down.

There are not many job opportunities in Vik in Mýrdalur but there are enormous opportunities for human resources. There is a limit to the fisheries quota in Iceland but there are no limits to the creative capacities of children, there is no one that can set limits to those ‘fisheries’, so of course
we should let them blossom, all of them.

**Introduction**

In a recent issue of School Science Review Jonathan Osborne voiced his concern about the attitudes of students to science and pondered about possible reasons and solutions to this problem (Osborne, 2008). We might develop more positive attitudes by fostering excitement, and activating curiosity and the students’ own processes of learning, of posing questions, looking for answers and creating new knowledge. These attributes are all elements of what has been called ‘innovation education’, a compulsory school subject in Iceland that has similarities to craft, design and technology education in England and other countries such as New Zealand (Banks and McCormic, 2006), Canada and Australia (Haché, 2006; Williams, 2006) and others. Among many aims that they have in common is the emphasis on design and problem solving, to develop the ability to use a variety of methods and processes to solve problems (Hill, 2006). Some of the pioneers of innovation education in Iceland were science teachers and the purpose of this article is to show the appeal of innovation education and creative teaching for science teachers. A practical and creative use of knowledge might be one way of making science interesting to students. Innovation education has properties that are useful in daily life, at school and in the work place.

I have been a compulsory school teacher for almost thirty years in a small rural primary school in Iceland and when I started teaching I soon discovered that not all students liked school or some even hated it. I always felt for those children but when I started teaching innovation education I finally felt that I was able to engage all of my students in active participation in learning. I taught innovation education for ten years and found that it included many elements of what I considered good education. The most rewarding experience would be to see students that formerly hated school were now working enthusiastically even in the free-periods to finish their creations for innovation education.

**Innovation Education in Iceland**

Innovation education (IE) is as mentioned before, a compulsory school subject in Iceland that first started to develop in Icelandic schools around 1990. It has many similarities to what in other countries is called technology education or design and technology education. Both technology education and innovation education aim at building an understanding of technologies in the widest sense giving prominence to problem solving and the design process (Haché, 2006; Jónsdóttir, 2005). In 1999 innovation education became a formal school subject in Iceland within the national curriculum for information and technology education (Ministry of Education, 1999). It is based on conceptual work which involves searching for needs and problems in the student’s environment and finding solutions to them (Denton and Thorsteinsson, 2003). In innovation education creativity is believed to be a generic personal trait in all individuals, which can be developed as a skill (Gunnarsdóttir, 2001). Innovation education requires schools and teachers to adopt a special frame of mind. It is a subject where the students influence their own learning and their own ideas provide the basis for their projects. Students have to be active and the teacher’s role is to facilitate and support the creative processes in the innovation work (Gunnarsdóttir, 2001; Jónsdóttir, 2006; Porsteinsson and Denton, 2003).

**Teaching Materials in Innovation Education**

The pedagogy and methods of IE were developed originally within the compulsory school Foldaskóli in Reykjavík the capital of Iceland (Jónsdóttir, 2005). Two pioneers in innovation education that were at the time teaching in Foldaskóli, Gísl í Porsteinsson and Rósa Gunnarsdóttir, developed and published four units of resource materials for teachers (Porsteinsson and Gunnarsdóttir, 1996) for the 4th to 7th grades and that have since been the main basis for teaching innovation education in compulsory schools in Iceland. The materials called *Innovation and Science* promote a systematic approach to teaching IE but reflecting the ideology that “people are the creators of their own world”. The materials were written with the aim of enhancing student creativity through teaching them certain ways of
working and expression, through new vocabulary and drawings. Each unit has a different main theme as reflected in the names of the units:

1. Initiative – creativity
2. Innovation – technology
3. Ideas – ingenuity
4. Environment – design

All of them have a core that includes training in the working ways of the inventor. This includes looking for needs, working on solutions, making notes in a small notebook, drawings and making models.

The materials also emphasize a connection to the life of work, as each unit contains a suggestion for a visit to a firm or an establishment that is relevant to that unit’s theme. In these materials a learning process is created that gives students opportunities to utilize knowledge from everyday life and knowledge that they acquire in school (Porsteinsson and Gunnarsdóttir, 1996). These teaching materials have been a source of influence in those schools that offer innovation education, the content of the National Curriculum and of the development of IE in Iceland.

Innovation Education in the Curriculum

The need for creativity and innovation is commonly acknowledged and is often heard in official discourses about business, science and technology. There is a contemporary need for people to be self-directed and a need for universal creativity world today (Jeffrey and Craft, 2006). Enhancing innovativeness and creativity should benefit science and arts, business and personal life. These needs for innovativeness and creativity were formally met in Iceland by introducing innovation education as a subject in the official curriculum for compulsory schools. The experience from the work in Foldaskóli and other schools in Iceland that followed its lead, led to a formal recognition of the subject of innovation education as part of the General Curriculum for Icelandic Compulsory Schools in 1999. In the curriculum it was placed in a section called Information and Technology Education with Carpentry and IT in a chapter called Innovation and Practical Use of Knowledge (Ministry of Education, 1999). The forewords to the chapter indicate a new way of thinking as a response to a changing reality:

The modern day worklife is increasingly built on working with knowledge and ideas. The conditions are constantly changing because of new technologies and knowledge. To be able to act in such a work environment individuals need to be able to adapt to innovations quickly, spot new possibilities in new knowledge as well as have the skills to utilize new knowledge and work it into valuable products (Ministry of Education, 1999, p, 9).

The subject did not get a special time allocation in the curriculum and it was either to be taught as a special subject or integrated with other subjects. There are four independent chapters in this curriculum: The use of computers, information education, innovation education and design and carpentry.

A Seaside School

We are in a large concrete one floor house in a small town on the south coast of Iceland. In the neighborhood the sea is relentlessly falling over the shore polishing stones and grains of sand, three huge peaks of rock protrude from the sea and give the town and the tall mountains an adventurous atmosphere. Outside the house there are five children about ten to eleven years old walking around talking and once in a while writing something in a small notebook. Inside the house we see four children of a similar age sitting in a half circle at a desk in the large hall working on a poster, drawing, writing, cutting pictures and gluing on a large dark green piece of paper. Just beside them there is a door open into a room with many
tables, a blackboard, a large desk, and bookshelves with lots of books, colorful posters and pictures on the shelves. In the room stands a lady with black long hair and dark brown eyes talking to a group of children of similar age as the ones we saw before. The woman talks slowly and is deeply engaged in what she is showing them. She is holding a strange thing made of Icelandic wool - a blanket formed as a kind of “seal” that you can crawl into and cuddle – and telling the children that this was made in the local knitting factory according to the design of some young people that were former students in the school. We are in the local compulsory school at Vik in Myrdalur in the south of Iceland.

The woman who has a rather southern look to her is called Kolbrún (the name means: the very dark brown) and she is the head of the school and also one of the main teachers. It is a small rural school with about 70 children aged 6–16 years. The children are taking an innovation education class. Kolbrún is one of the pioneers in teaching innovation education in compulsory schools in Iceland. The children outside are looking for needs or problems to write in their notebook and later they will brainstorm on about possible solutions to solve them. Some of these solutions will be used to make the environment better or some will be developed further into business ideas. When they start to look at their environment this way they develop a sense for treating it well and for seeing opportunities that are otherwise hidden.

Pioneers of Innovation Education

Some schools in Iceland have been offering innovation education since it started around 1990 although the majority of compulsory schools offer no formal teaching in innovation education (Jónsdóttir, 2005). But there are teachers who have become deeply committed to the subject including the author. Rósa and Kolbrún are compulsory school teachers that were involved with instigating and developing innovation education in compulsory school work in Iceland. I interviewed both of them separately in the summer of 2008 and build the information presented about them on those interviews and available documentation. Both are initially educated science teachers and both had excellent experience with teaching innovation education.

Rósa taught in a new compulsory school (ages from 6-16 years, student population growing from 600-1200 students in the years of Rósa’s teaching) in Reykjavík and was responsible for teaching science in the oldest classes (14–16 years). Kolbrún was and is a teacher and the headmaster of a small rural compulsory school in the south of Iceland in the town Vik. Both have a teacher’s degree from the University of Education (three years B.Ed.) and specialized in science teaching (Rósa in physics and Kolbrún in biology). Kolbrún told me

In the compulsory school of Myrdalshreppur we tend to mix it all together so to speak. I have been teaching IE from 1990 and before that I had in some ways been teaching like that. In the rural areas we have been thinking about making new job opportunities – often as extra work alongside other work. So the issues of employment and work have been a sort of midpoint, we know we have to teach our kids to be able to do so many things and often on their own. This has been the spirit of all this innovation work. There are not many job opportunities in Vik in Myrdalur but there are enormous opportunities for human resources. There is a limit to the fisheries quota in Iceland but there are no limits to the creative capacities of children, there is no one that can set limits to those ‘fisheries’, so of course we should let them blossom, all of them.

A Suburban School
The room has all the classic symptoms of classroom, the large blackboard hanging on the wall, tables arranged in a group formation, large windows set on the left side of the room in Victorian fashion. On the teacher's desk in front of the blackboard sits a woman in her late twenties talking to a group of young people about 15-16 years old scattered in a semi-orderly fashion around the classroom facing the woman. This is a classroom in a compulsory school in Reykjavík, the woman is Rósa, a science teacher and the young people are her students. Rósa is also an innovation education teacher in the school and she tends to use the methods of innovation education in her science teaching as well. Rósa tells them that they are going to carry on with the work from the last lesson.

Gradually the class rearranges themselves into smaller groups chatting and forming plans about their tasks. Some take plastic bags out of a cupboard, telling Rósa they are going out to collect trash as they leave the room. Another group tells Rósa they are going out to look at the fauna and collect plants for their research and ask her advice on how best to gather them. A third group of four students, starts two computers in the room and sit down by them. The fourth group asks Rósa if it is okay that they go out, they want to take photographs of the man-made things that they have defined in the surroundings in earlier lessons. They are looking at the relationship between the man-made environment of the bay in which they live and the protected ecology of the bay. Half of the class is concentrating on the natural environment and the other half on the man-made environment.

The 'kids', as Rósa refers to her students, have themselves come up with their own research plans, and are now starting to execute them or are in the process of making short introduction to their chosen research subject to their class mates and other teachers in the school. Rósa says smiling, "I feel a bit like a walking dictionary today as all the kids do is ask me about thing they want to know and are important to them, instead of the usual me telling them what they should know, whether they want to or not". And off she goes, answering another call for a chat or assistance with some things related to projects and to be honest to life it self.

**Teacher Characteristics**

Both teachers Rósa and Kolbrún, expressed abundant respect for children and their abilities to be creative, to spot possibilities, to learn, and to make decisions about their learning. Kolbrún finds children very creative and good thinkers: “Finding solutions and being creative, that’s how children think all the time, they are so open and they constantly have new ideas”. Rósa had a great belief in what her 15 year old students could do and gave them opportunities to take part in a science contest for 15–20 year old participants: “I would let them analyze the task by themselves, design a research plan, build the research tools, conduct the research and make a poster to show the findings and give an introduction for the judges.”

Both teachers seem to have a creative mind that they actively used in their teaching and at times showed inventiveness and initiative. Rósa said that when she started to teach science she wanted to do it without the textbooks so she spent the summer vacation organizing the teaching so she could implement the necessary learning opportunities. “I taught this semester without textbooks and used them only as tools, literally as tangible tools; we used them for throwing out the window to measure the force of gravity. We were on the first floor and it was suitable to put ten books together because it made 1, 5 kilograms and throw them out the window connected to the meter and we got a very nice printout. It worked very well to have the students try this out. I let them organize the experiments and just said: This is what we are trying to look at and we will try to find out why these things happen”. Kolbrún saw immense possibilities in teaching in the small rural school and has been utilizing the various firms around in the small town, visiting the local Museum of Culture, using the sand and the beach for
inspiration and learning. When she started teaching there she soon discovered that they were teaching some of the elements in the curriculum twice in different subjects so she started to design large projects that would integrate many subjects. Kolbrún and her co-workers would plan a project and visit the National Park at Thingvellir where they would cover a considerable part of the curriculum: “you had everything there, the history, the geology, the nature, the art and the poetry”.

Innovation education is built primarily on looking for needs so what we tell the kids is that they should always be looking around and be critical of their environment and I mean everything. So the lessons are about finding a lot of needs, something that needs solutions, something new, everything is considered. Then we may sort them into categories of some sort. Then there is a lot of work with ideas, the ideation process. The students work either independently or in groups. We have used the environment around us a lot. We have a great rural district museum at Skógar where we have an ocean of so many things, so many solutions, so many versions and it is simply a university in this context. We have the museum of transportation; we have the whole history of the implementation of electricity that is very interesting in this area. We need to feed them with this, even when they are very young, seven to eight years old, they can understand these things.

And we also use the small firms in the town for learning and cooperation; we have a small woodwork industry and a small knitting factory. We can come for a visit in these firms and see how an idea comes about and is developed into a product that is sold in shops. So they are brought up with seeing that “you know, I can think of something and I can make it become something.” So they have it all around them and you just have to ignite them, at least it seems to me that there is never a lack of ideas from these kids. They are oceans of ideas and naturally they may not all, maybe fortunately, become business ideas. We also use environmental education a lot in connection with innovation education; it gave a lot of new dimensions. (Kolbrún, interview).

The teaching of both teachers indicates that they have the ability to cross boundaries that others would find restricting. They would do many kinds of experiments, be somewhat impulsive, and find doing new things “no problem”, be able to tolerate a certain amount of chaos and have fun teaching.
Conclusion

Both teachers I interviewed taught some lessons as ‘formal innovation education’, i.e. a consecutive period of lessons focusing on learning and practicing the methods and thinking processes of the inventor. They both also used innovation education as a tool in other lessons, especially in science. Kolbrún said she thought using innovation education was especially useful in environmental studies. A new project on Educational Action for Sustainable Development (Action ESD), in Icelandic schools, has included innovation education as one of the tools to be used in project schools (Bergmann et al., 2008). In my own teaching I have found innovation education useful as a way for students to understand technology and science as they researched environments and invented objects and technologies that they made themselves, thereby gaining a deeper insight than only by learning ‘about’ technology or science. Although it seems clear to me that both of the teachers I have been describing are very creative and probably are great teachers without innovation education, I think it is no coincidence that they were pioneers in innovation education as it allows creative ways of teaching which builds on creative ways of student learning. I found innovation education to be a kind of all in one ‘packet’ that included everything that education should have: relevance to students’ lives, their own building of knowledge and understanding through creativity, connections to ordinary life and the workplace, versatile ways of teaching, diverse ways of learning, the use of many kinds of knowledge from other school subjects and ‘from life itself’ and finally every student had the opportunity to become somewhat of a specialist and to do something well. I also noticed that when students had come to grips with the main tools of innovation education, they could use them within most other subjects, though particularly in technology and science.
Main Aims of Innovation Education in the 1999 Curriculum

There are three components to the curriculum for Innovation and the practical use of knowledge:

- Information and technology literacy
- Idea, solution, product
- Individual, technology, society

Information and Technology Literacy

Information and technology literacy includes the acquisition by students of the knowledge, skills and technology needed to develop their own idea into a visible product. The main emphasis should come on the knowledge and technological areas of the particular school subject being integrated with innovation at any one time. Through this component there is an opportunity to train students in self-directed studies, to introduce to others the outcomes of gathering information, to teach others about new knowledge and skills and so on.

Idea, Solution, Product

This component includes acquisition by students of methods of actualizing an idea from the first notion of an idea to a developed product. The emphasis is on students learning about professional methods of ideation, development and the manufacture of products. This part forms the bulk of the subject and can among other things include project plans that the students follow. In the development of this component it is important to take into account the particular professional methods of the arts, academic or practical subjects into which innovation and the practical use of knowledge is being integrated.

Individual, Technology and Environment

This component includes aims about increasing the awareness of students to the reciprocal connections between individuals, technology and environment. As in the former components the emphasis must be on connecting innovation and the practical use of knowledge to the particular subjects with which it is being integrated. To take an example, if innovation is being integrated with sport, then the goal of this component could be that students collect information on and discuss the relationship between science and performance in sport, the history of sport and the importance of sport in society.

References


